Exhibit 3 – Expert Report of Dr. Soderberg

Keir Soderberg, PhD
S. S. Papadopulos & Associates, Inc.
1801 Rockville Pike, Suite 220
Rockville, Maryland 20852

September 11, 2023

T. David Hoyle, Esquire
Motley Rice, LLC
28 Bridgeside Blvd.
Mt. Pleasant, SC 29464

In re: New Indy Emissions Litigation
U.S. District Court, District of South Carolina, Rock Hill Division
Civil Action Nos. 0:21-CV-1480-SAL; 0:21-CV-01704-SAL

RULE 26(A)(2)(b) REPORT OF KEIR SODERBERG

Dear Mr. Hoyle:

At your request, I have prepared a report containing my opinions concerning the New Indy Containerboard Facility and, more specifically, the mapping of odor complaints and air modeling results.

This report is based on my education, training and experience as an environmental scientist, my research in the fields of geochemistry and hydrology, as well my review of the discovery materials identified in Attachment C. All of the opinions expressed in my report are based upon a reasonable degree of scientific certainty.

I anticipate receiving additional discovery materials as they become available including any additional depositions of employees or corporate representatives of New-Indy Catawba, LLC ("NI Catawba"), of New-Indy Containerboard, LLC ("NI Containerboard"), and third-party witnesses. Accordingly, I reserve the right to amend this report, as needed, to reflect any such new information.

My billing rate is $249 per hour for the time I devote to work on this inquiry.

My current CV, including a list of my prior testimony for the prior four years, and of my publications is included as Attachment B to this report.

Qualifications

I am an Associate with S. S. Papadopulos & Associates, Inc., in Rockville, Maryland. I have worked for this company for more than 15 years. I have an undergraduate degree in civil and environmental engineering from Princeton University, a master's degree in environmental geochemistry from the University of Cape Town, and a Ph.D. in environmental science from the University of Virginia. My Ph.D. focused on isotope geochemistry and hydrology, and I also completed two years of post-doctoral research on the same topics with Princeton University. In my professional career I have specialized in the characterization of chemicals in the environment, including their spatial distribution, potential sources, fate and transport. The mapping of spatial information, such as that discussed in this report, has been an integral part of my research and professional work for more than 20 years.

Background on Purpose of Report/What Was Requested

As you have explained, Plaintiffs are proposed representatives of a class of individuals residing in the area around the New Indy Facility.

You have asked my opinion as to how to map odor complaints, HYSPLIT model results, and AERMOD model results. I mapped odor complaints using information provided by the South Carolina Department of Health and Environmental Control (DHEC), and I mapped the model results provided by other experts in this case. The facts and data considered in forming the opinions below are listed in Attachment C.

Summary of Opinions

- Opinion 1: Scientific and mathematical techniques can be utilized to circumscribe the main area of odor complaints, and I applied those techniques to the odor complaint data from DHEC.
    - Basis for Opinion 1: Weekly mapping of odor complaints was provided by DHEC. I combined the weekly maps for four time periods of interest ("Phases") and created an outline of the main area of odor complaints for each phase after excluding outliers using a nearest neighbor analysis.
- Opinion 2: Computer mapping techniques can be used to render HYSPLIT model trajectories and an associated buffer, and I applied those mapping techniques to HYSPLIT model results provided by Dr. Vizuete.
    - Basis for Opinion 2: HYSPLIT model trajectories were provided to me by another expert in this case, Dr. William Vizuete. Dr. Vizuete also indicated that the resolution of the HYSPLIT model input data was 3 kilometers.
- Opinion 3: Computer mapping techniques can be used to render AERMOD modeling results of hydrogen sulfide concentration, and I applied those mapping techniques to AERMOD model results provided by Dr. Hanna.

- Basis for Opinion 3: AERMOD modeling results were provided to me at the direction of another expert in this case, Dr. Steven Hanna. I extracted the continuous contour representing a concentration of 600 parts per billion (ppb) hydrogen sulfide.

Detailed Discussion of Opinion #1.

Opinion 1: Scientific and mathematical techniques can be utilized to circumscribe the main area of odor complaints, and I applied those techniques to the odor complaint data from DHEC.

DHEC provided weekly odor complaint maps compiled as a video available on their website (DHEC 2023a, 2023b). At my direction, my team extracted the odor complaint points from these compiled weekly maps using geospatial image processing tools as detailed in Attachment D of this report. The extracted points were grouped into four phases:

- Phase 1: January through May 2021
- Phase 2: June through August 2021
- Phase 3: September 2021 through August 2022
- Phase 4: September 2022 through November 7, 2022
  - Phase 4 extended: September 2022 through July 10, 2023

For each Phase, a nearest neighbor analysis of outliers (Muhr et al., 2023) was conducted to identify the main odor complaint area. The logic behind this technique is the farther a point is from the next closest points, the more likely it is to be an outlier. For each odor complaint point in a Phase, the mean distance to its ten closest points was calculated, resulting in a distribution of distance values. An outlier was identified as a point with a nearest neighbor distance more than three standard deviations from the average. The non-outliers were then circumscribed by a "convex hull" (*i.e.*, the convex polygon that encloses a set of points with the shortest perimeter) to ensure that none were excluded from the outline of the main odor complaint area for each Phase. The results of this analysis, the odor complaint points and odor complaint areas for each Phase, are shown in Figures 1-1 through 1-5.

During our analysis, DHEC provided additional mapping for Phase 4 (DHEC, 2023b). We have incorporated these into a Phase 4 extended mapping. We noted that Phase 4 extended had a different type of statistical distribution, making a non-parametric outlier cutoff more appropriate. Therefore, we used the 99th percentile to identify outliers in the Phase 4 extended map. We also applied the 99th percentile cutoff to the other three phases with similar results to the initial mapping (Figures 1-6 and 1-7).

I also calculated the areas (ESRI Arcmap 10.8.1) within each of the outlines shown on Figures 1-1 through 1-7, and used U.S. Census data (U. S. Census Bureau, 2022) to determine the population within each outline. To avoid overcounting the population in census tabulation blocks that overlapped the edge of the outline of interest, the population in each block was scaled

down in proportion to the fraction of the block that fell within the outline of interest. The resulting areas and populations are as follows:

- Phase 1, Figure 1-1 (three standard deviations): 511 square miles, population 527,936
- Phase 2, Figure 1-2 (three standard deviations): 420 square miles, population 455,890
- Phase 3, Figure 1-3 (three standard deviations): 420 square miles, population 410,301
- Phase 4, Figure 1-4 (three standard deviations): 232 square miles, population 221,695
- Phase 4 extended, Figure 1-6 (99th percentile): 343 square miles, population 319,283
- Phase 1, Figure 1-7 (99th percentile): 526 square miles, population 546,884
- Phase 2, Figure 1-7 (99th percentile): 420 square miles, population 455,890
- Phase 3, Figure 1-7 (99th percentile): 401 square miles, population 396,464

The following addresses for class representatives were geolocated and plotted on Figures 1-1 through 1-7.

- Orrin & Melda Gain: 722 Kathy Dianne Drive, Indian Land, SC 29707
- Terri & Marty Kennedy: 362 Cotton Field Road, Indian Land, SC 29707
- Enrique & Sansanee Lizano: 6046 Drave Lane, Fort Mill, SC 29720
- Shane & Tracie Nickell: 4114 Lesslie Highway, Catawba, SC 29704
- Amanda & Shara Swager: 3176 Greenwood Road, Rock Hill, SC 29730
- Kenny White: 9932 Mitchell Glen Drive, Charlotte, NC 28277

The conclusion that scientific and mathematical techniques can be utilized to circumscribe the main area of odor complaints is held with a reasonable degree of scientific certainty.

Detailed Discussion of Opinion #2.

Opinion 2: Computer mapping techniques can be used to render HYSPLIT model trajectories and an associated buffer, and I applied those mapping techniques to HYSPLIT model results provided by Dr. Vizuete.

The HYSPLIT model from the U.S. National Oceanic and Atmospheric Administration (https://www.ready.noaa.gov/HYSPLIT.php) provides air-parcel back-trajectories on an hourly basis. Dr. William Vizuete provided five trajectories, which I mapped as lines with a 1.5 kilometer buffer on each side of the lines (Figures 2-1 through 2-4). This mapping was done using ESRI's ArcMap software (Version 10.8.1). The overall width of the buffer reflects the 3 kilometer resolution of the input data to HYSPLIT, as specified by Dr. Vizuete.

Also shown on Figures 2-1 through 2-4 are odor complaints in the buffer zone that occurred on the same day as the HYSPLIT trajectory. The daily odor complaint information was supplied by DHEC to Dr. Vizuete who geo-located the odor complaints and provided the spatial coordinates to me.

The conclusion that computer mapping can be used to render HYSPLIT trajectories and associated buffers is held with a reasonable degree of scientific certainty.

Detailed Discussion of Opinion #3.

Opinion 3: Computer mapping techniques can be used to render AERMOD modeling results of hydrogen sulfide concentration, and I applied those mapping techniques to AERMOD model results provided by Dr. Hanna.

AERMOD model results for hydrogen sulfide concentrations, overall maximum averaged over a 30-minute interval, were provided to me under the direction of Dr. Steven Hanna. Two types of results were provided: interpolated results, and raw data points. I mapped a continuous contour from Dr. Hanna's interpolated results representing 600 ppb hydrogen sulfide (Figure 3-1).

For comparison, I also mapped the raw data points after performing a LOESS smoothing procedure (Figure 3-2). The raw data points are arranged in 360 rays, each representing one degree of a circle centered on the New Indy Facility. For each degree, I determined the maximum distance from the center of the circle where the model calculated a concentration exceeding 600 ppb. I then arranged these 360 data points as a linear sequence, with 20 data points wrapped at each end to allow the smoothed ends to match, and created a curve using LOESS smoothing (span parameter of 0.11; r-package gamlss).

I also determined the area and population within the hydrogen sulfide concentration outlines shown in Figures 3-1 and 3-2 using the same methodology as described under Opinion 1 above. The resulting areas and populations are as follows:

- Hydrogen Sulfide 600 ppb, Figure 3-1 (AERMOD contour): 1,227 square miles; population 843,742.
- Hydrogen Sulfide 600 ppb, Figure 3-2 (LOESS smoothed contour): 1,057 square miles; population 778,480.

The conclusion that computer mapping can be used to render AERMOD modeling results of hydrogen sulfide concentration is held with a reasonable degree of scientific certainty.

Conclusion

The mapping performed as a basis for Opinion 1 confirms that the odor complaint data points for each Phase can be circumscribed in a reproducible way that represents and reflects the information provided by DHEC. If additional odor complaint data becomes available, these maps can be updated.

The mapping performed as a basis for Opinion 2 represents and reflects the results of HYSPLIT modeling and uncertainty information provided by Dr. Vizuete.

The mapping performed as a basis for Opinion 3 represents and reflects the results of AERMOD modeling provided by Dr. Hanna.

Sincerely,

Keir Soderberg, PhD

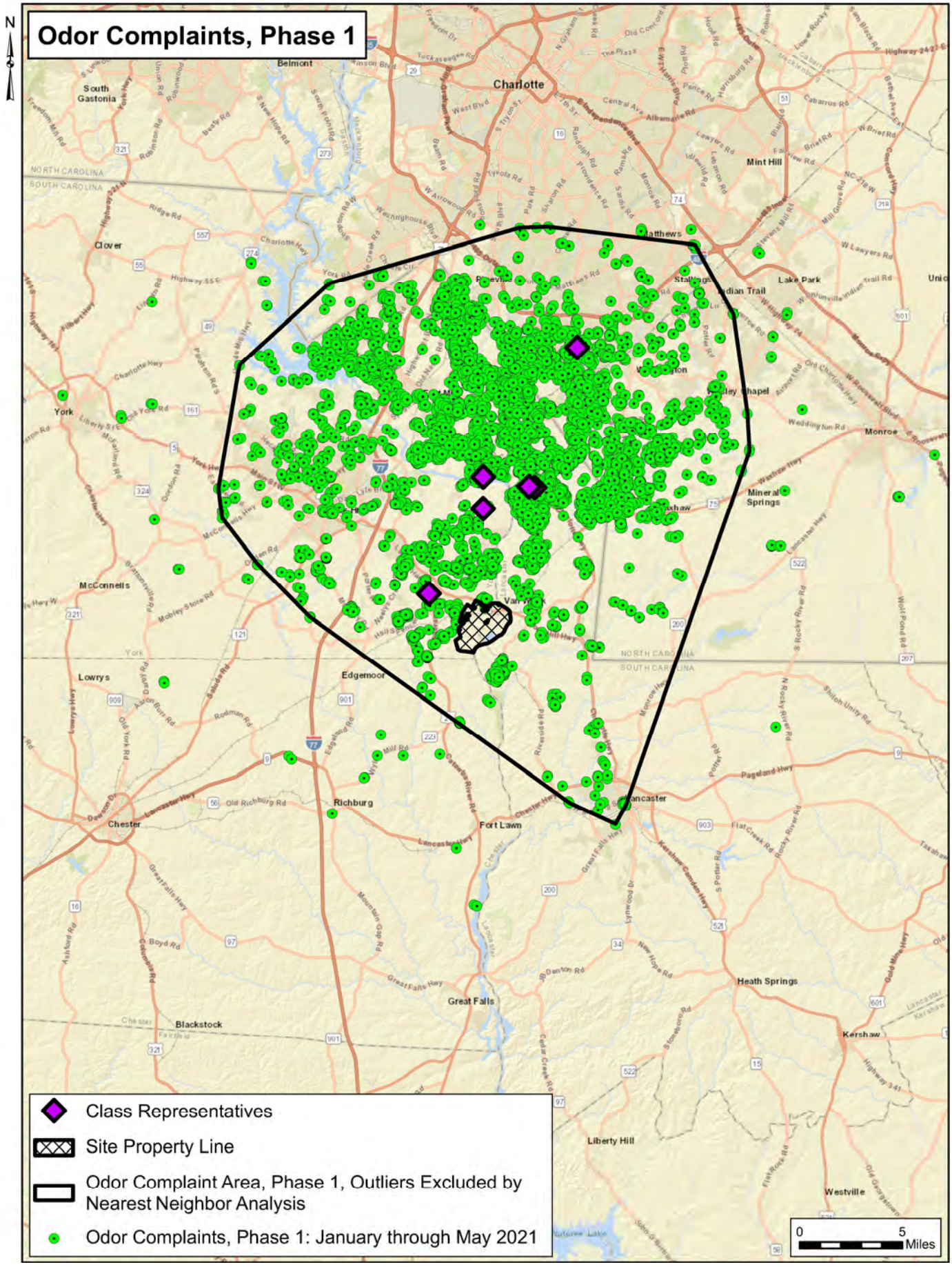
Attachments:

A. Figures
B. Curriculum vitae of Expert
C. Materials Considered
D. Geospatial Image Processing

Attachment A

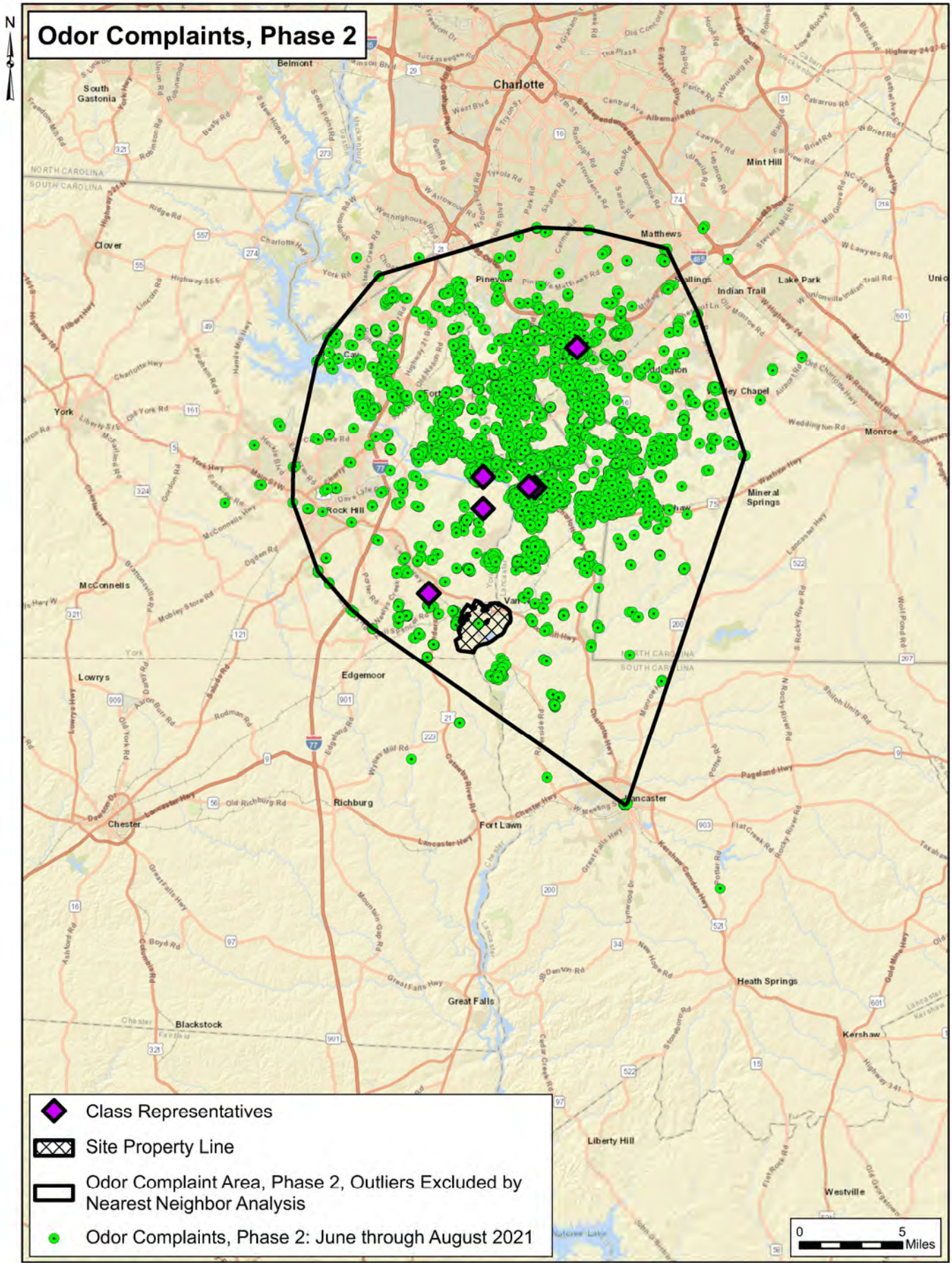
Figures

Attachment A: Figures



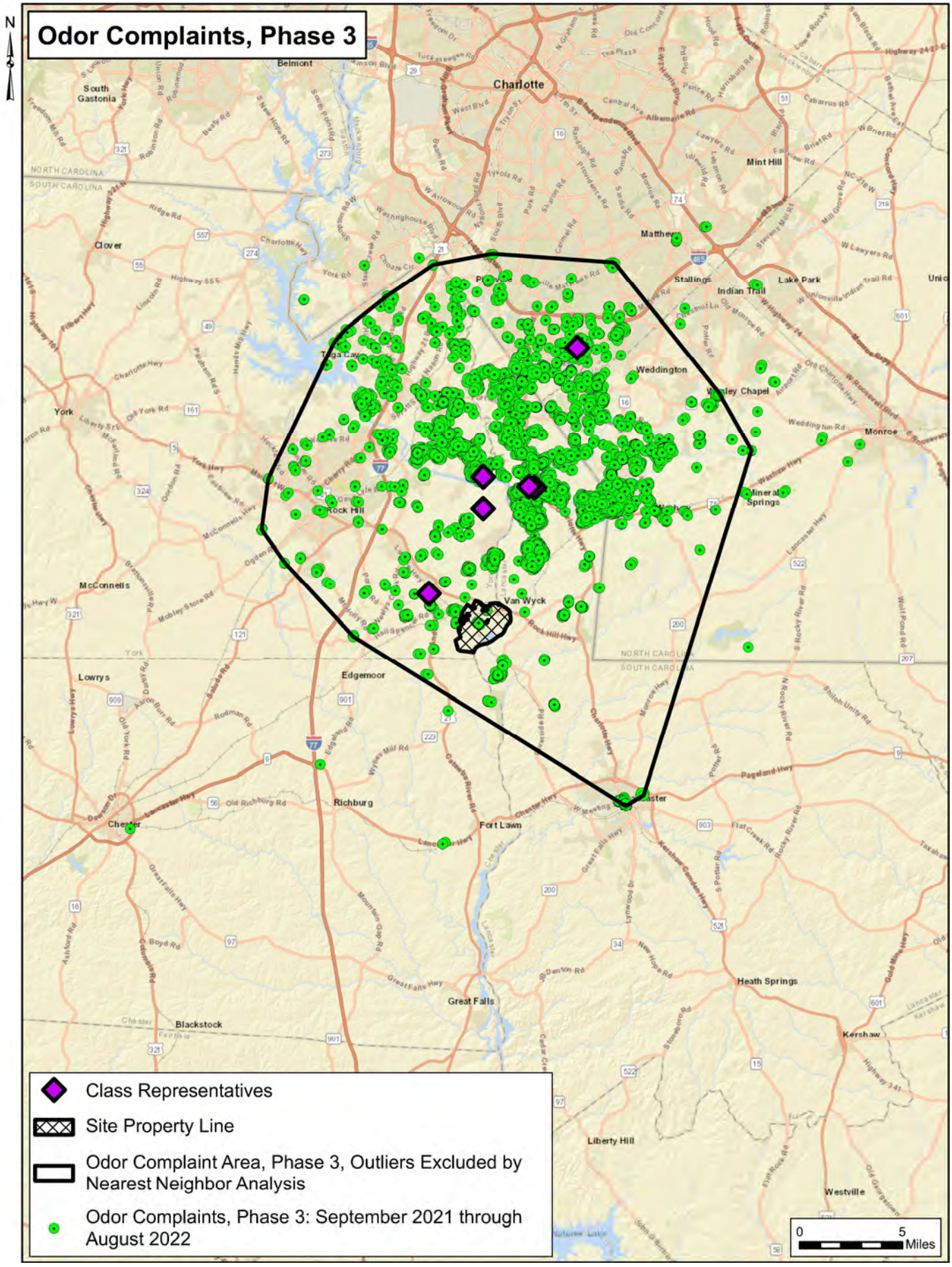
Data Sources: South Carolina DHEC. New Indy Odor Investigation, https://scdhec.gov/environment/environmental-sites-projects-permits-interest/new-indy-odor-investigation Accessed August 17, 2023

Figure 1-1. Odor Complaints, Phase 1



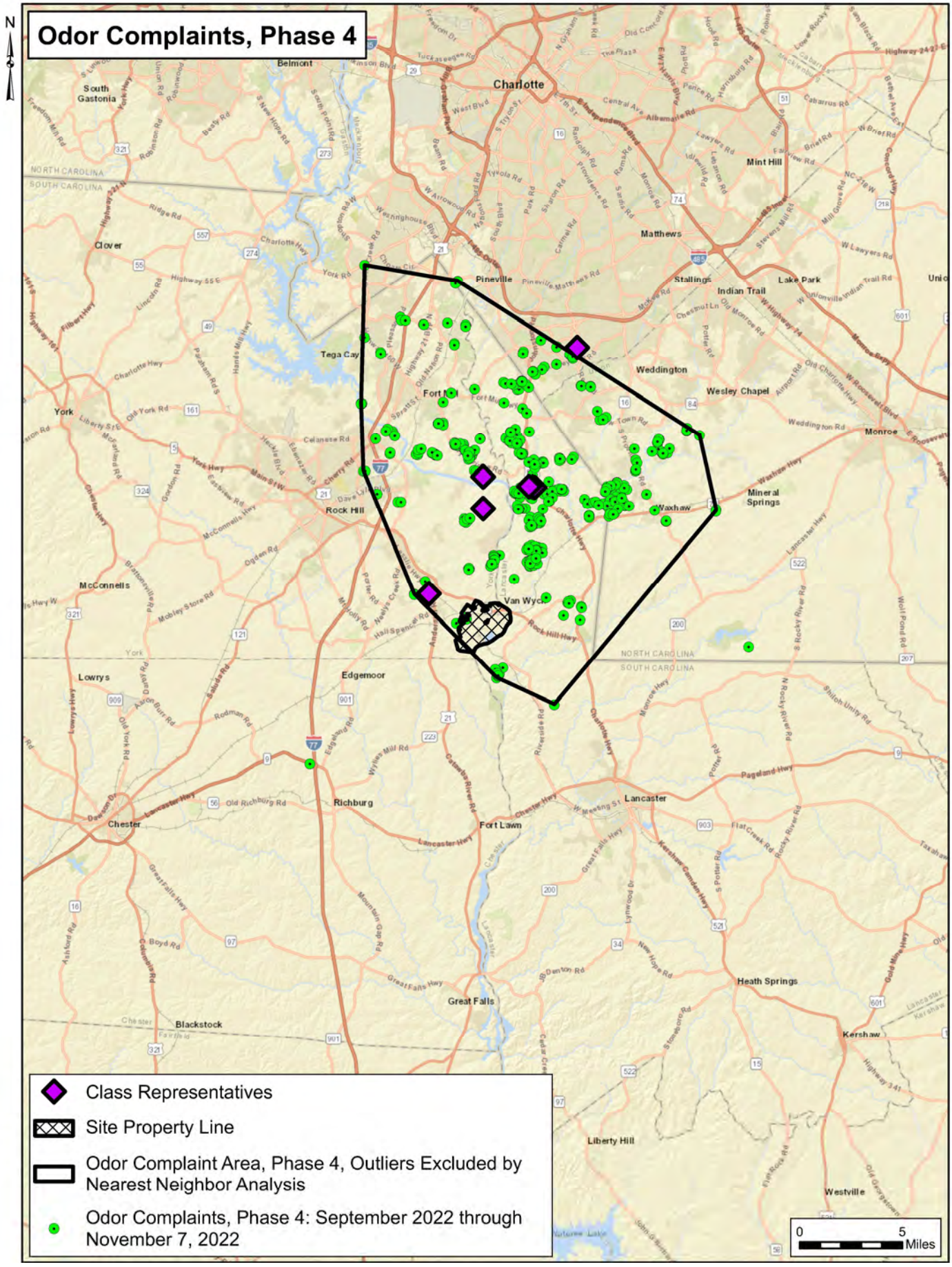
Data Sources: South Carolina DHEC. New Indy Odor Investigation, https://scdhec.gov/environment/environmental-sites-projects-permits-interest/new-indy-odor-investigation Accessed August 17, 2023

Figure 1-2. Odor Complaints, Phase 2



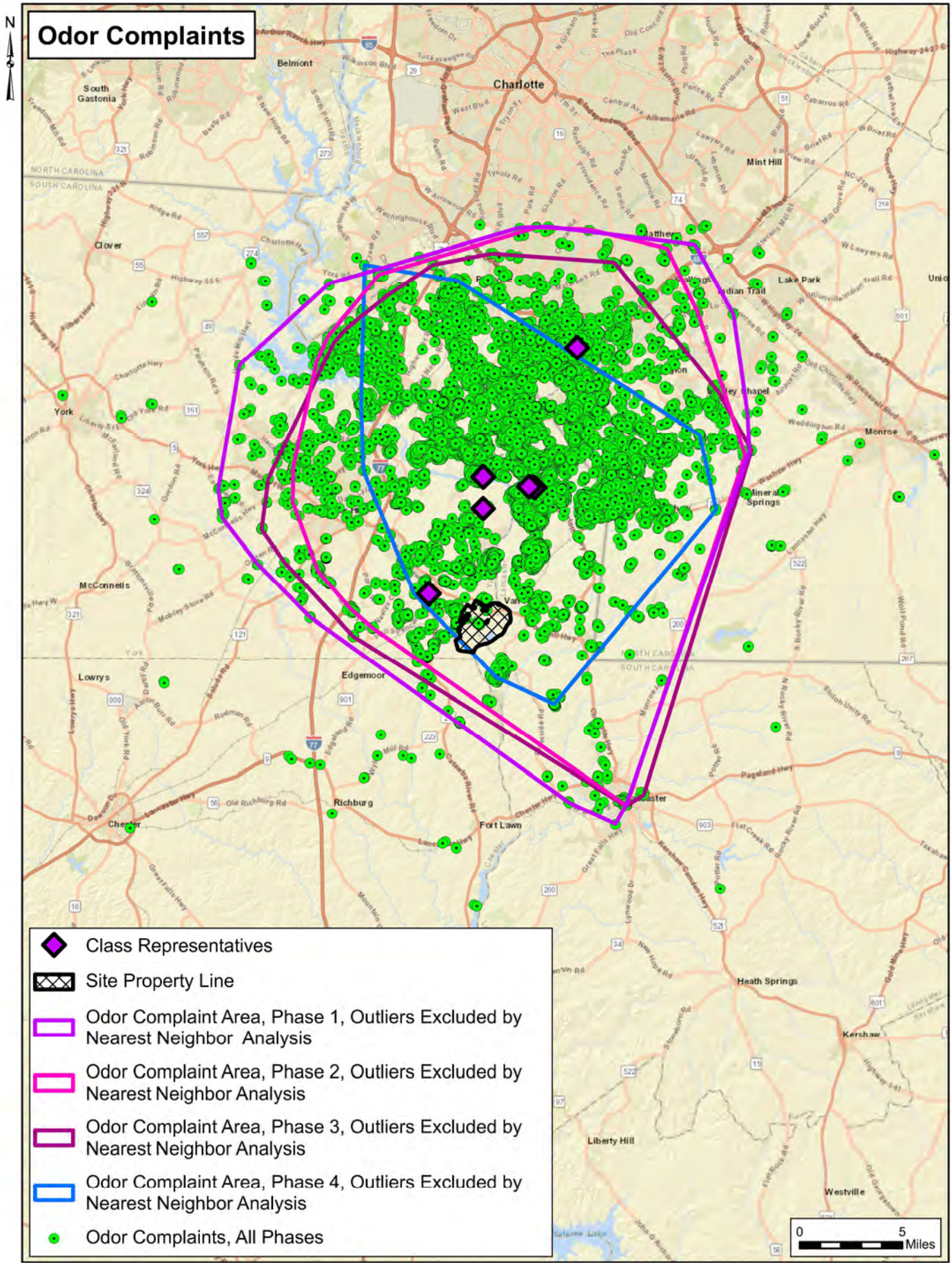
Data Sources: South Carolina DHEC. New Indy Odor Investigation, https://scdhec.gov/environment/environmental-sites-projects-permits-interest/new-indy-odor-investigation Accessed August 17, 2023

Figure 1-3. Odor Complaints, Phase 3



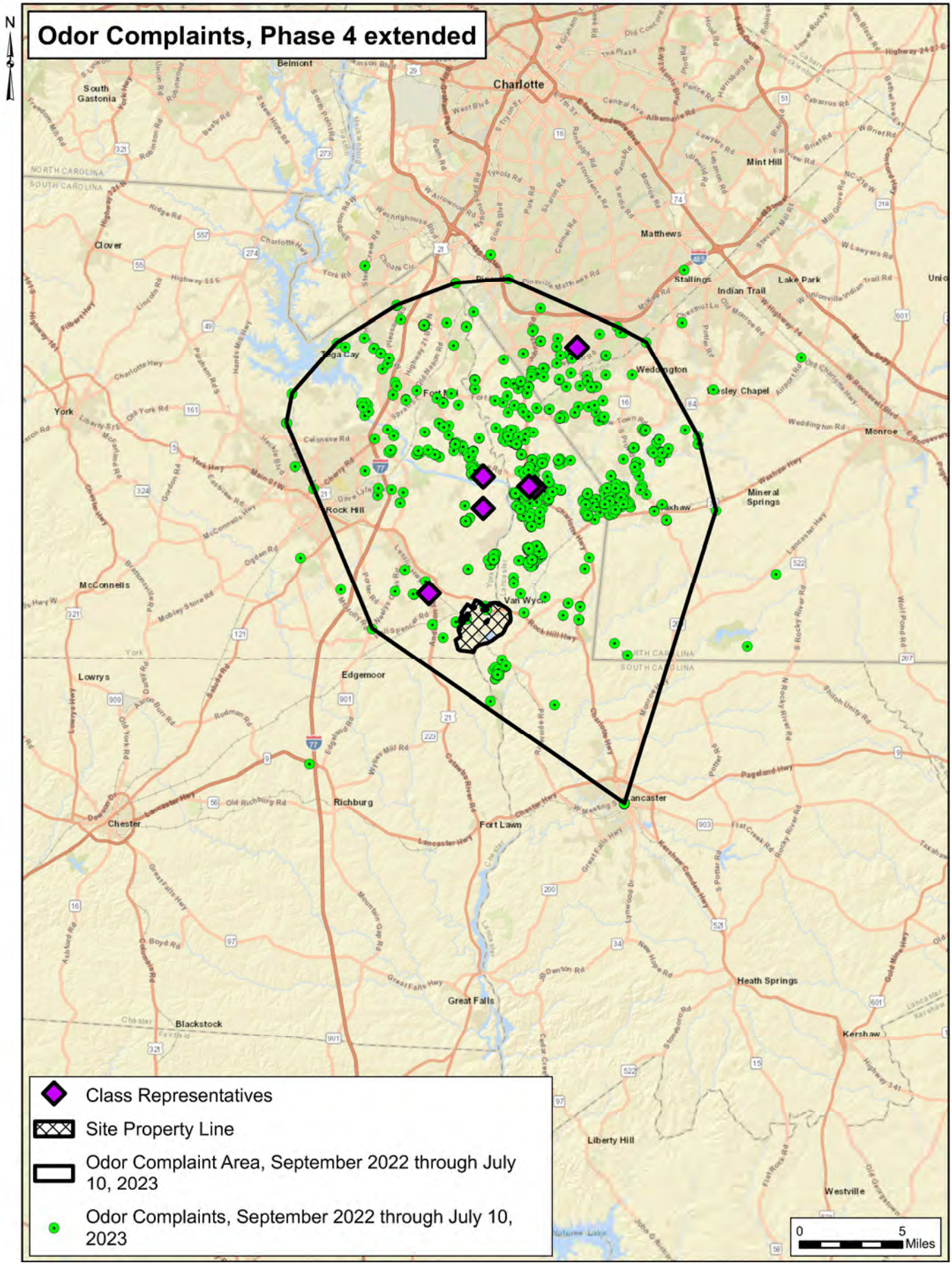
Data Sources: South Carolina DHEC. New Indy Odor Investigation, https://scdhec.gov/environment/environmental-sites-projects-permits-interest/new-indy-odor-investigation Accessed August 17, 2023

Figure 1-4. Odor Complaints, Phase 4



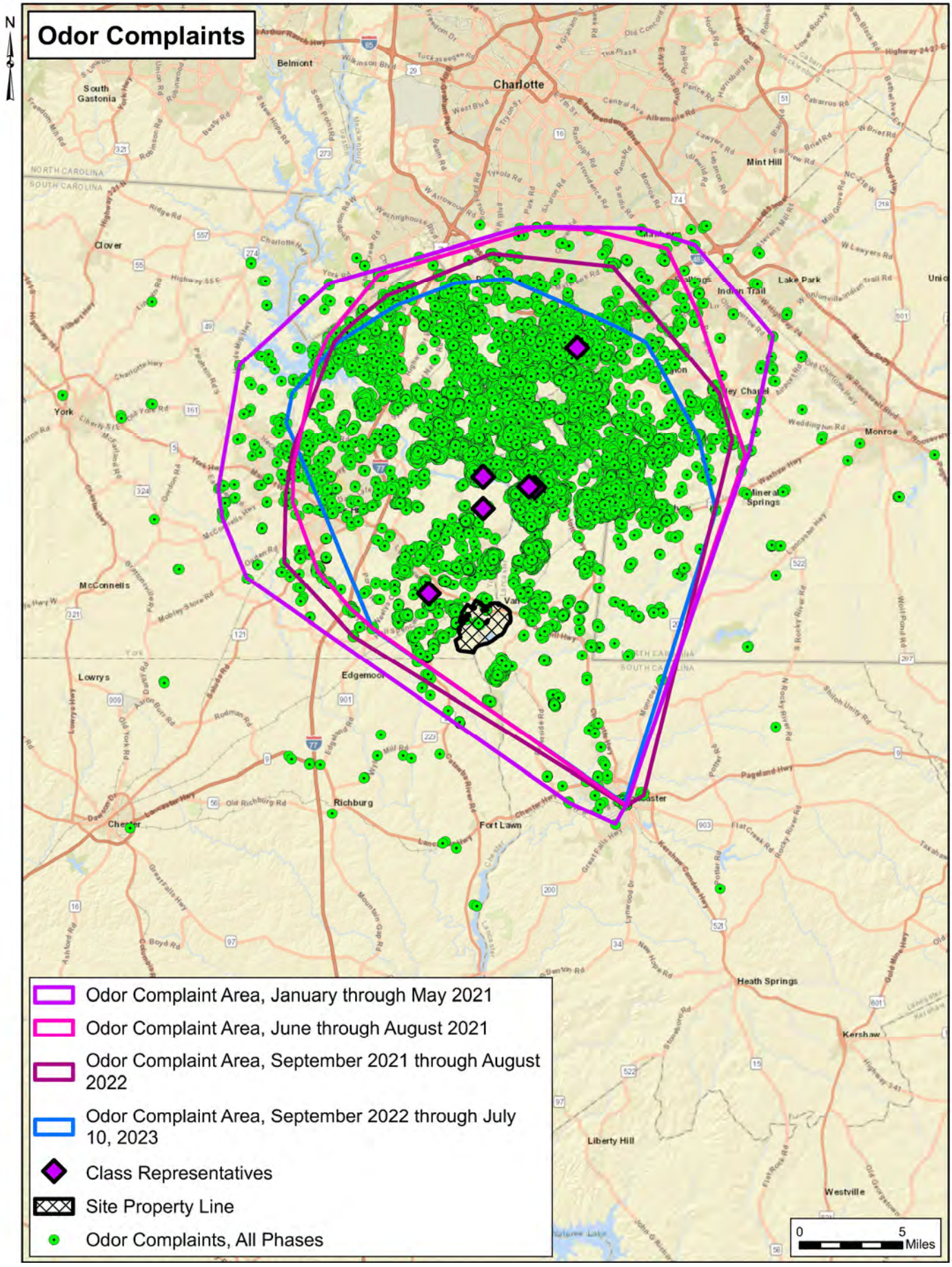
Data Sources: South Carolina DHEC. New Indy Odor Investigation, https://scdhec.gov/environment/environmental-sites-projects-permits-interest/new-indy-odor-investigation Accessed August 17, 2023

Figure 1-5. Odor Complaints, Phases 1 through 4



Data Sources: South Carolina DHEC. New Indy Odor Investigation, https://scdhec.gov/environment/environmental-sites-projects-permits-interest/new-indy-odor-investigation

Figure 1-6. Odor Complaints, Phase 4 Extended



Data Sources: South Carolina DHEC. New Indy Odor Investigation, https://scdhec.gov/environment/environmental-sites-projects-permits-interest/new-indy-odor-investigation

Figure 1-7. Odor Complaints, Phases 1 through 4 Extended

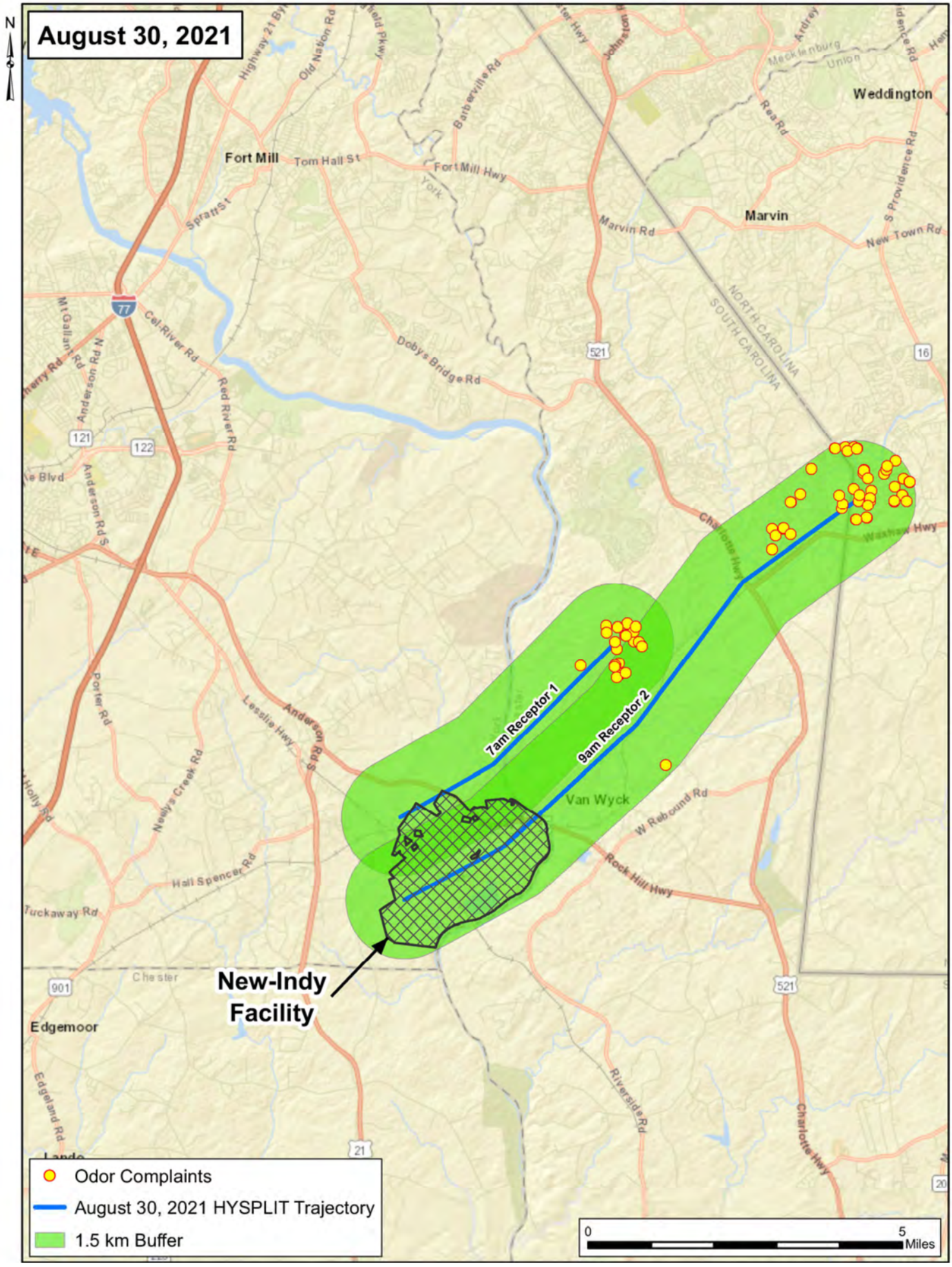


Figure 2-1. HYSPLIT Model Results, August 30, 2021

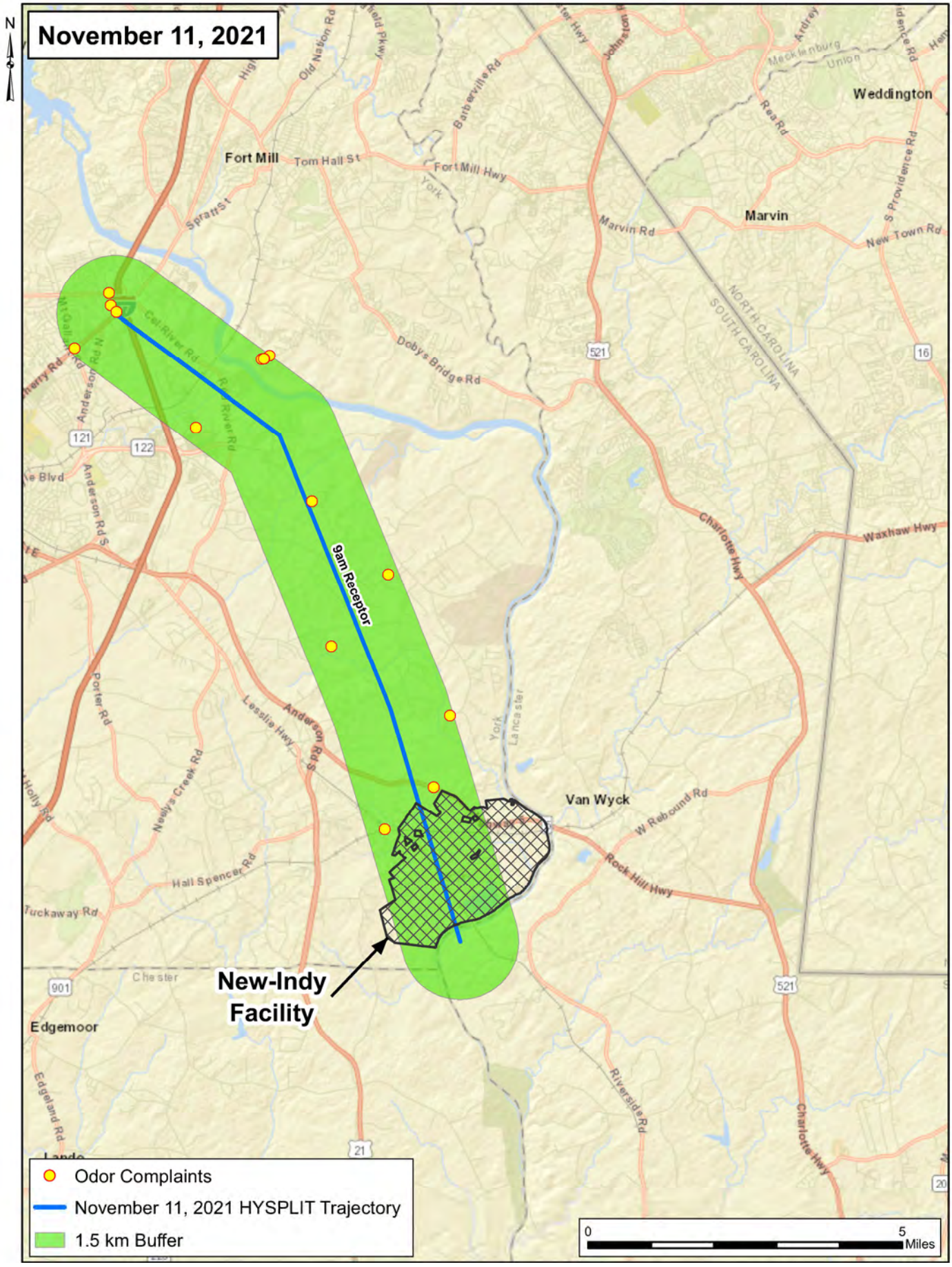


Figure 2-2. HYSPLIT Model Results, November 11, 2021

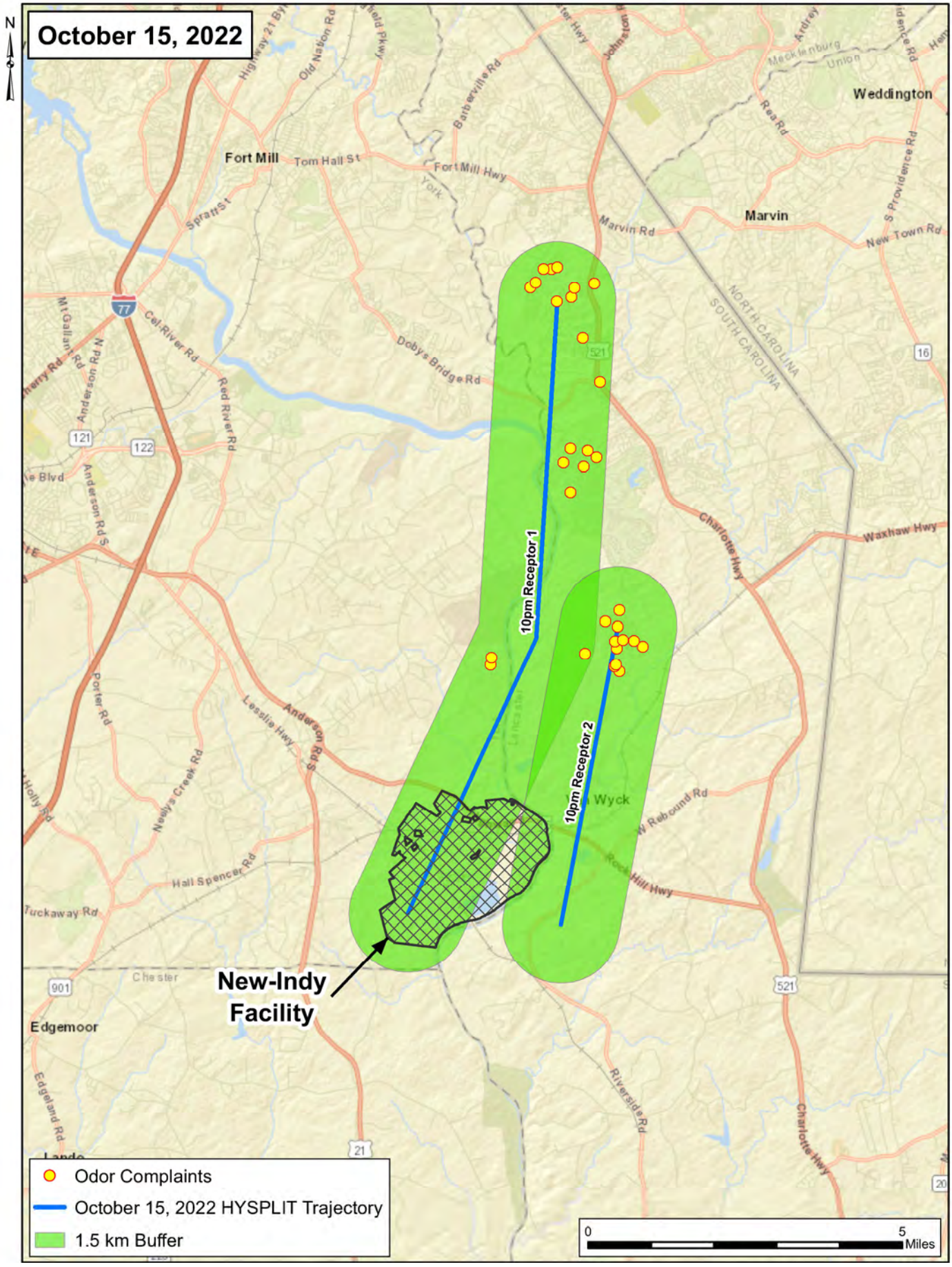


Figure 2-3. HYSPLIT Model Results, October 15, 2022

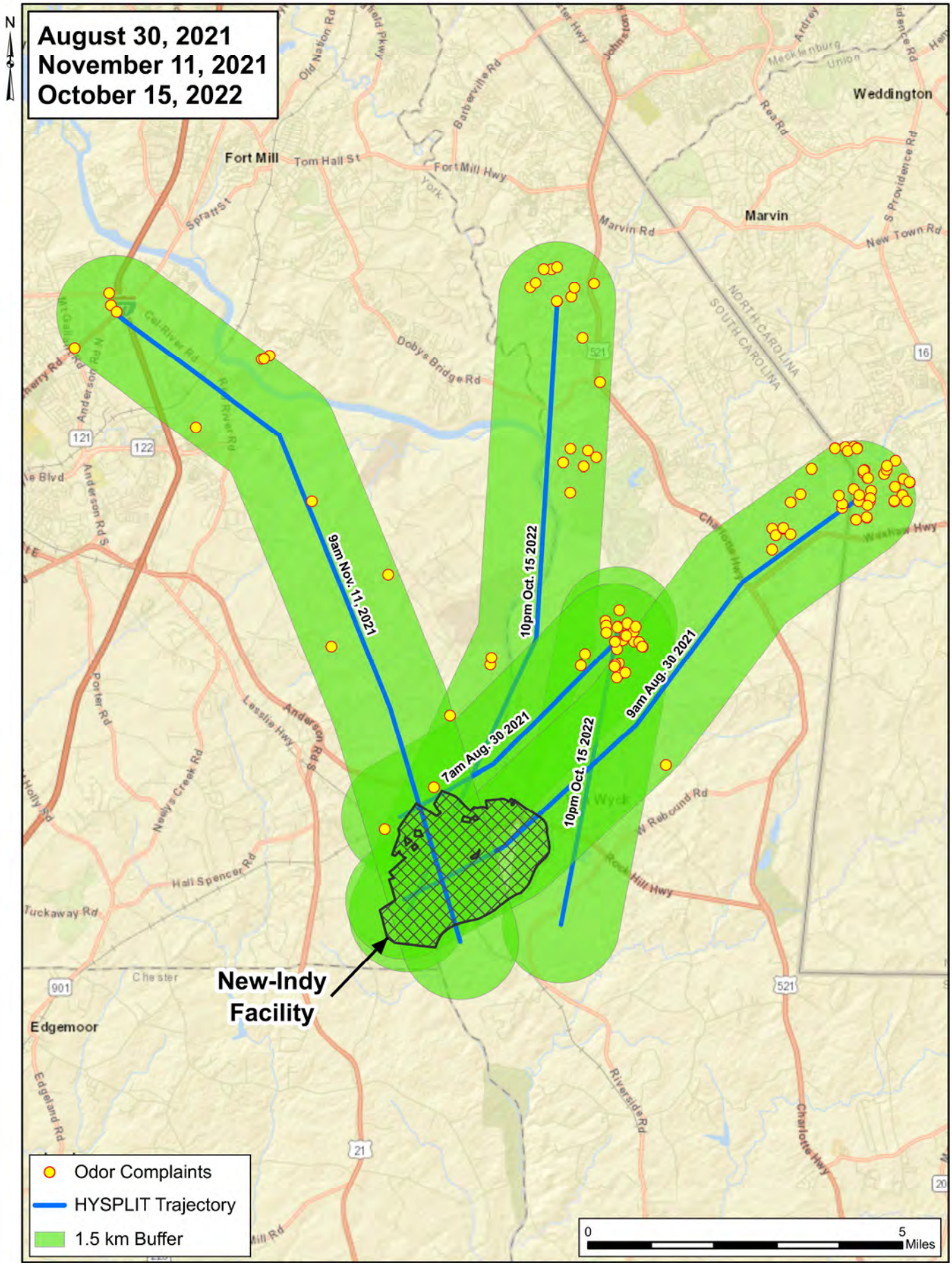


Figure 2-4. HYSPLIT Model Results, All Days

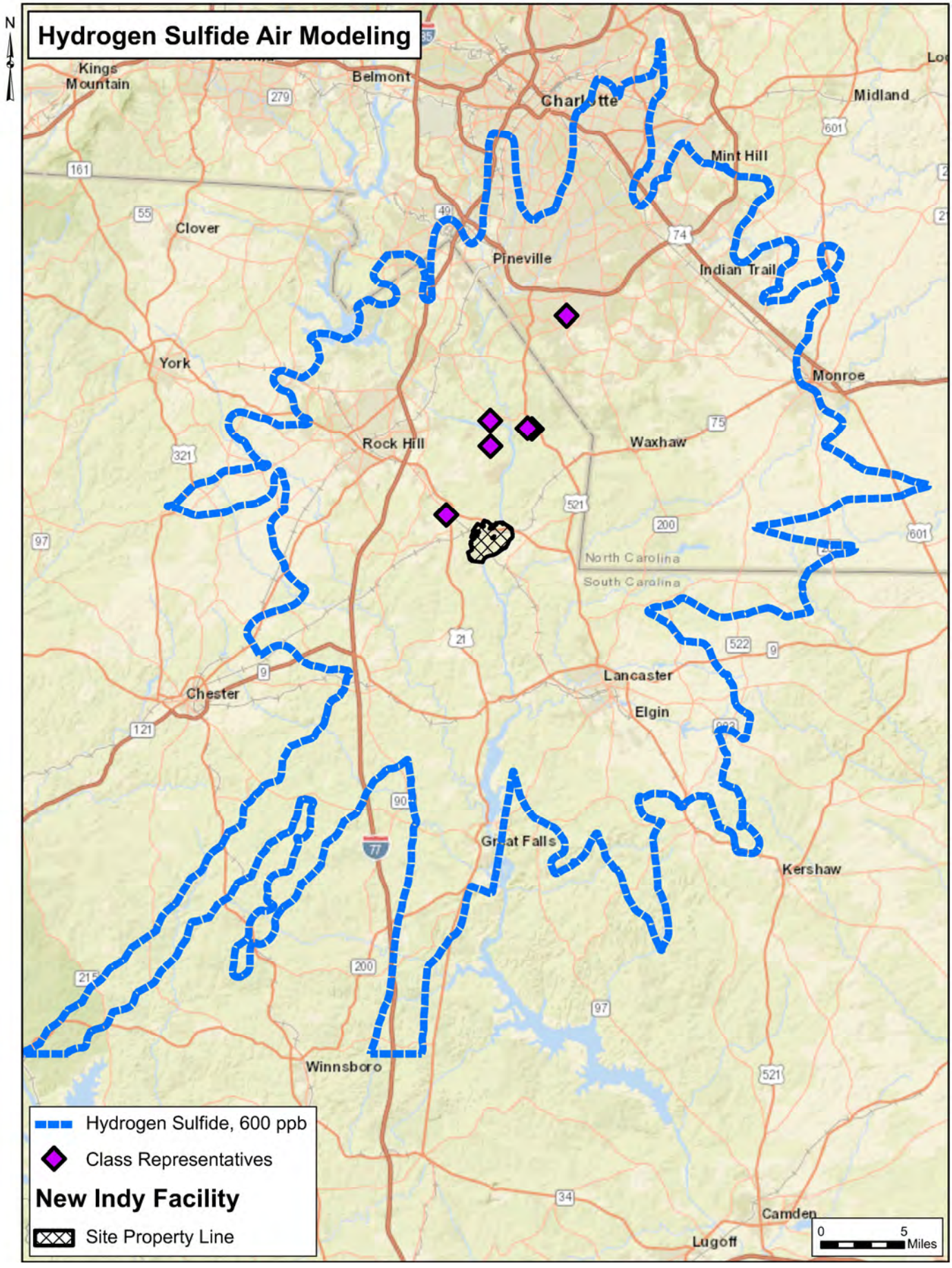


Figure 3-1. AERMOD Model Results

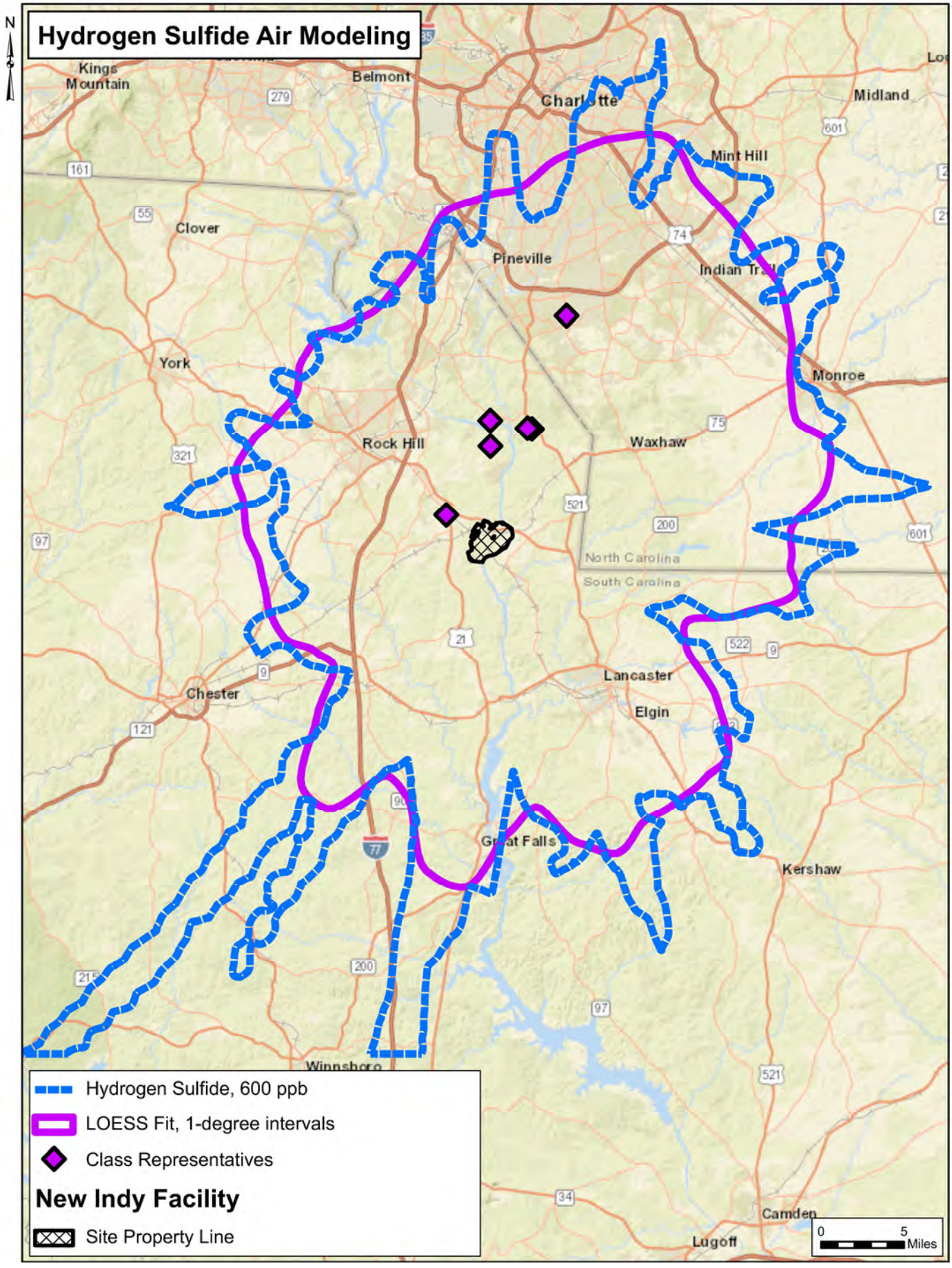


Figure 3-2. AERMOD Model Results with LOESS Smoothing

Attachment B

Curriculum vitae of Expert

KEIR SODERBERG

Associate, Senior Geochemist

AREAS OF EXPERTISE

- Isotope Hydrology
- Biogeochemistry
- Ecohydrology
- Field Instrumentation
- Analytical Chemistry
- Environmental Forensics

SUMMARY OF QUALIFICATIONS

Dr. Soderberg's expertise covers isotope hydrology, environmental geochemistry, ecohydrology, and human impacts on ecosystems. His experience, including five years in sub-Saharan Africa, has involved project development, field and laboratory chemistry, analysis of satellite imagery, geochemical modeling, and management of large datasets. Through the combination of rapid *in situ* measurements of water isotopes and eddy covariance flux technology, Dr. Soderberg has helped advance the understanding of evapotranspiration dynamics in semi-arid lands. He has also utilized multiple stable and radiogenic isotope tracers to determine the impacts of atmospheric inputs on ecosystem functioning.

With SSP&A, Dr. Soderberg has had extensive experience with environmental forensics, allocation of remedial costs, site characterization, and the evaluation of remedial alternatives. These projects have involved the characterization and remediation of groundwater, surface water, soil, and sediments. Some of the chemical constituents that Dr. Soderberg has evaluated (*e.g.*, for source identification, background determination, fate and transport) include perchlorate, pharmaceuticals, radionuclides, per/polyfluorinated alkyl substances (PFAS), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and dioxins/furans.

YEARS OF EXPERIENCE: 15+

EDUCATION

PhD, Environmental Sciences, University of Virginia, 2010
MS, Environmental Geochemistry, University of Cape Town, 2003
BSE, Civil and Environmental Engineering, Princeton University, 2000

PROFESSIONAL HISTORY

S.S. Papadopulos & Associates, Inc., Associate, 2018 to present
Senior Scientist, 2016 – 2018; Senior Project Geochemist, 2013 – 2016; Project Geochemist, 2012 – 2013; Staff Geochemist, 2003 – 2007; Intern, 2000
Princeton University, Postdoctoral Research Associate, Dept. Civil and Environmental Engineering, 2010 – 2012
University of Virginia, Teaching and Research Assistant, Dept. of Environmental Sciences, 2006 – 2009
Desert Research Foundation of Namibia, Fulbright Scholar, 2007
University of Cape Town, Princeton-in-Africa Fellow, Assistant Lecturer, Dept. of Mathematics and Applied Mathematics, 2001 – 2002

REPRESENTATIVE EXPERIENCE

S.S. Papadopulos & Associates, Inc., Rockville, Maryland

ENVIRONMENTAL FORENSICS, LITIGATION, AND ALLOCATION

- **State of Minnesota v. 3M Company,** East Metro Area, Minnesota — The State brought this litigation against 3M for damaging natural resources through the release of PFAS. Dr. Soderberg collected water and sediment samples to characterize PFAS distribution across a 200 square mile area to help characterize the extent of natural resources impacts for this litigation. He provided an expert report and deposition testimony about the sample collection and data quality evaluation. The litigation was settled for $850 million prior to trial.
- **Private Client,** Berry's Creek, New Jersey — Established a framework for allocating remedial costs that incorporated the spatial distribution of chemicals of concern (e.g., mercury, PCBs, chromium) in sediments, uplands soil concentrations, the history of usage in hundreds of potential sources, and sediment transport dynamics. A forensic evaluation of PCB sources involved the analysis of congener data as well as manual chromatogram review for Aroclor determination.
- **Private Client,** Union City, Indiana — Used geochemical signatures in soils and river sediments for PCB source allocation considering both calibrated and raw analytical data. This analysis involved automated extraction and processing of raw data for all quantitated chromatographic peaks, as well

KEIR SODERBERG

Associate, Senior Geochemist

as working directly with the laboratory to discuss changes in operating conditions and to run specialized standards.

- **Cuppels et al. v. Mountaire Corporation,** Millsboro, Delaware — A class action lawsuit was brought against Mountaire for the release of nitrogen and other chemicals from a poultry processing facility. Dr. Soderberg analyzed nitrogen loading from the application of fertilizer, wastewater, and sludge on agricultural fields and forested areas. Transformation of nitrogen species as well as leaching to groundwater and surface water were assessed in the context of groundwater flow patterns and total nitrogen loads in the watershed. Mountaire agreed to a $65 million settlement for injuries and damages allegedly caused by Mountaire's environmental practices. A separate but related consent decree with the State of Delaware required the company to spend $120 million to upgrade its wastewater treatment facility and another $20 million to maintain safe practices.
- **Private Client,** New Mexico — Provided an analysis of geochemical signatures relating to uranium mining activities to evaluate the impacts of both underground mining and surface activities such as the management of exploratory borehole cuttings and mill tailings storage.
- **Private Client,** Elmira, Ontario — Assisted in the development and evaluation of geochemical models using stable isotopes and major ion chemistry. The models were used for the allocation of ammonia loading to two potential source areas.
- **Private Client,** Louisiana — Used stable isotopes ($\delta^{13}C$, $\delta^{18}O$, and $\delta^{2}H$) of dissolved carbon dioxide and methane to help interpret patterns and processes relating to methane in shallow groundwater before and after the excavation of petroleum-impacted soil.
- **U.S. Department of Justice,** Georgia — Evaluated the residual impact of a recycling operation that handled solvent-impacted materials.
- **City of Portland,** Oregon — Used PCB patterns and the presence of associated chlorinated compounds in soil and sediment samples for the identification of likely sources of PCBs to the Willamette River.
- **Private Client,** South Carolina — Interpreted noble gas isotope results for age-dating of groundwater. Worked with a university laboratory to design an appropriate sampling protocol, arrange for analyses, and discuss the results.

REMEDIAL DESIGN AND EVALUATION

- **Private Client,** Oklahoma — A former missile motor cleanout site required characterization of perchlorate, nitrate and other constituents related to rocket propellants in soil and groundwater. In support of remediation and litigation, Dr. Soderberg evaluated background perchlorate concentrations, determined the extent of site-related perchlorate in groundwater, and helped develop remedial actions at a former spent missile processing facility. The evaluation also included research into the evolution of analytical techniques for perchlorate over time. This is an ongoing remediation involving *in situ* (*e.g.*, bioreactor) and *ex situ* (*e.g.*, ion exchange) treatment of perchlorate that Dr. Soderberg has been working on for more than 10 years.
- **Private Client,** Illinois — Delivered testimony commenting on the coal ash management rules proposed by the Illinois EPA.
- **U.S. Department of Justice,** Idaho — Provided an analysis of herbicide transport and degradation rates in agricultural soils.
- **Private Client, Pensacola,** Florida — Provided statistical analysis of trends in chemical data, and evaluated radionuclide analytical data quality for an agrichemical facility.
- **Private Client,** Mississippi — Helped select and evaluate devices for obtaining samples of groundwater with high concentrations of methane in a deep aquifer. Also used stable isotopes to evaluate the source of free gas in surface water.

KEIR SODERBERG

Associate, Senior Geochemist

- **U.S. Department of Justice,** Maine — Evaluated the remediation of chromium contamination in sludge drying lagoons associated with a chrome tanning operation.

Princeton University, Princeton, New Jersey

During two years at Professor Kelly Caylor's Ecohydrology Laboratory at Mpala Research Center in Kenya, managed a stable isotope laboratory, an eddy covariance flux tower, and field monitoring activities. This work used stable isotopes of water to investigate evapotranspiration dynamics, and ultimately to measure water use efficiency at the landscape scale. A unique aspect of this work is the continuous (1 Hz) measurement of water vapor isotopes in the field. Hired and trained four Kenyan research assistants, and mentored several undergraduate student interns.

University of Virginia, Charlottesville, Virginia

PhD research on the water relations and geochemistry of desert ecosystems in the Central Namib Desert, Namibia. Stable isotopes were used to investigate nutrient cycling, fog-dust interactions, and the amount of fog water used by various species including the floristically unique *Welwitschia mirabilis*. Served as Teaching Assistant on several courses at the University of Virginia including GIS Methods, Engineering in Community Settings, and the study abroad course *People, Culture and Environment of Southern Africa*.

University of Cape Town, Cape Town, South Africa

Studied the geochemistry of fynbos ecosystems in the Cape Floristic Region biodiversity hotspot. The research focused on the cycling and origin of minor and micro-nutrients for the vegetation in a poorly buffered, acidic environment. Isotopes of lead and strontium were a useful complement to differentiate urban, terrestrial and marine inputs.

PROFESSIONAL SOCIETIES

International Association of Geochemistry
National Groundwater Association
American Geophysical Union

AWARDS AND HONORS

Top Downloaded Paper, Ecohydrology, 2018-2019
AGU Citation for Excellence in Reviewing, JGR-Biogeosciences, 2018
Buckner W. Clay Fellowship, University of Virginia, Graduate School of Arts and Sciences, 2009
G.A. Harris Fellowship, Decagon Devices, Inc., 2009
Michael Garstang Award for Interdisciplinary Research in Atmospheric Sciences, University of Virginia, Department of Environmental Sciences, 2008
Huskey Research Symposium Award, University of Virginia, 2008
Fulbright Scholarship, Desert Research Foundation of Namibia, 2006

APPOINTMENTS

2013–2023: Reviewer for Journal of Hydrology
2023: Reviewer for Agricultural and Forest Meteorology Journal
2022: Proposal Reviewer for the U.S. Environmental Protection Agency, STAR Program
2015–2022: Reviewer for Journal of Geophysical Research – Biogeosciences
2021: Reviewer for Scientific Data Journal
2013–2021: Reviewer for Geoderma
2012–2020: Reviewer for Ecohydrology

KEIR SODERBERG

Associate, Senior Geochemist

2018: External PhD Committee Member, Department of Earth Sciences, IUPUI
2017–2018: Reviewer for Journal of Geophysical Research – Atmospheres
2015: Reviewer for Hydrological Processes
2013: Proposal Reviewer for the National Science Foundation, Hydrologic Sciences
2011: Reviewer for Geophysical Research Letters

PUBLICATIONS AND PRESENTATIONS (* peer reviewed journal)

*Zahn, E., E. Bou-Zeid, S. Good, G.G. Katul, C.K. Thomas, K. Ghannam, J.A. Smith, M. Chamecki, N.L. Dias, J.D. Fuentes, J.G. Alfieri, H. Kwon, K. Caylor, Z. Gao, K. Soderberg, N.E. Bambach, L.E. Hipps, J.H. Prueger and W.P. Kustas, 2022. Direct Partitioning of Eddy-Covariance Water Vapor and Carbon Dioxide Fluxes into Ground and Plant Components. Agricultural and Forest Meteorology: v. 315: 108790. doi: 10.1016/j.agrformet.2021.108790.

*Henschel, J. R., T. D. Wassenaar, A. Kanandjembo, M. K. Louw, G. Neef, T. Shuuya, and K. Soderberg, 2019. Roots point to water sources of Welwitschia mirabilis in a hyperarid desert. Ecohydrology. e2039. doi:10.1002/eco.2039

*Li, S., N.E. Levin, K. Soderberg, K.J. Dennis, and K.K. Caylor, 2017. Triple Oxygen Isotope Composition of Leaf Water in Mpala, central Kenya. Earth and Planetary Science Letters: 468, 38-50. doi:10.1016/j.epsl.2017.02.015

*Chambers, L.G., et al., 2016. Developing the Scientific Framework for Urban Geochemistry. Applied Geochemistry, v. 67, pp. 1-20.

Soderberg, K., D.P. McCarthy and R.J-C. Hennet, 2015. Volatilization of Polychlorinated Biphenyls: Implication for their Distribution, Forensics and Toxicity in Urban Environments. Presentation at the Geological Society of America Annual Meeting, November 1-4, 2015, Baltimore, MD.

Hennet, R.J-C. and K. Soderberg, 2015. Pharmaceutical Fingerprinting as a Dating Tool for Recent Sediments. Contaminated Sediments: Environmental Chemistry, Ecotoxicology and Engineering. Ascona, Switzerland, March 8-13, 2015.

*Soderberg, K., J. Henschel, R.J. Swap, and S.A. Macko, 2014. Sulphur Isotopes in the Central Namib Desert Ecosystem. Transactions of the Royal Society of South Africa, v. 69, no.3, pp. 217-223. doi: 10.1080/0035919X.2014.976778

*Good, S.P., K. Soderberg, K. Guan, E.G. King, T. Scanlon, and K.K. Caylor, 2014. δ^2H Isotopic Flux Partitioning of Evapotranspiration over a Grass Field Following a Water Pulse and Subsequent Dry Down. Water Resources Research, v. 50, no. 2, pp. 1410-1432. doi: 10.1002/2013WR014333.

Soderberg, K., and R. J-C. Hennet, 2014. Using Raw Chromatographic Data for PCB Source Allocation. Presentation at the IAGC Urban Geochemistry Working Group Meeting, August 5-6, 2014, Columbus, OH.

Dennis, K.J., K.K. Caylor, K. Soderberg, S. Li, N. Levin, T. Cerling, and M. Bende, 2014. Reconstructing Terrestrial Environments Using Oxygen Isotopes in Biogenic Apatite: A Modern Case Study from Mpala and Tsavo, Kenya. Presentation at the Goldschmidt Conference, Sacramento, CA.

Soderberg, K. and R.J-C. Hennet. 2014. Detection of Pharmaceuticals in the Environment: History of use as a Forensic Tool. in Goldstein, W. ed., Pharmaceutical Accumulation the Environment: Prevention, Control, Health Effects and Economic Impact. CRC Press: Boca Raton, FL. 262 pp.

Mihm, K., K. Soderberg, M. Nelson, S. Britt, 2014. Passive Grab Sampling for Dissolved Methane at Depth with the Sealed in-situ Snap Sampler Device. Presentation at the National Ground Water Association, Groundwater Summit, Denver, CO.

*Soderberg, K., Good, S P., L. Wang, M. O'Connor, K. Ryan, and K K. Caylor, 2013. Using Atmospheric Trajectories to Model the Isotopic Composition of Rainfall in Central Kenya. Ecosphere, v. 4, art. 33.

*Wang, L., S. Niu, S.P. Good, K. Soderberg, X. Zhou, J. Xia, R.A. Sherry, Y. Luo, K K. Caylor, and M.F. McCabe, 2013. The Effect of Warming on Grassland Evapotranspiration Partitioning Using Laser-based Isotope Monitoring Techniques. Geochimica et Cosmochimica Acta, v. 111, pp. 28-38.

Soderberg, K., C. Gerlein, P.C. Kemeney, and K.K. Caylor, 2013. Isotopic Equilibrium Between Precipitation and Water Vapor: Evidence from Continental Rains in Central Kenya. Presentation at the American Geophysical Union (AGU) Fall Meeting, Abstract GC13A-1057.

Li, S., N. Levin, K. Soderberg, K.J. Dennis, and K.K. Caylor, 2013. The Triple Oxygen Isotope Composition of Leaf Waters in Mpala, Central Kenya. Presentation at the American Geophysical Union (AGU) Fall Meeting, Abstract PP23C-1976.

Gerlein, C., K. Soderberg, P.C. Kemeney, and K.K. Caylor, 2013. Rain-Vapor Isotopic Equilibrium in Central Kenya. Presentation at the First International Workshop on Advances in Observations, Models and Measurement Techniques of Atmospheric Water Vapor Isotopes. October 17, 2013. CNRS, France.

Good, S., M. O'Connor, K. Soderberg, L. Wang, and K. Caylor, 2013. Analysis of the Distribution of the Isotopic Composition of Evapotranspiration Flux in a Semi-arid Savanna. Presentation at the EGU General Assembly, Vienna, Austria. Abstract EGU2013-9991.

*Soderberg, K., S.P. Good, L. Wang, and K.K. Caylor, 2012. Stable Isotopes of Water Vapor in the Vadose Zone: A Review of Measurement and Modeling Techniques. Vadose Zone Journal, v. 11, no. 3.

*Good, S.P., K. Soderberg, L. Wang, and K.K. Caylor, 2012. Uncertainties in the Assessment of the Isotopic Composition of Surface Fluxes: A Direct Comparison of Techniques Using Laser-based Water Vapor Isotope Analyzers. Journal of Geophysical Research – Atmospheres. v. 117, D15301.

*Eckardt, F., K. Soderberg, L.J. Coop, A. Muller, K.J. Vickery, R.D. Grandin, C. Jack, T.S. Kapalanga, and J. Henschel, 2012. The Nature of Moisture at Gobabeb in the Central Namib Desert. Journal of Arid Environments. doi: 10.1016/j.jaridenv.2012.01.011

Soderberg, K., J.M. Gitonga, and K.K. Caylor, 2012. Establishing a Water Isotope Framework for Investigating Ecosystem Functioning and Agricultural Water Use in Central Kenya. Presentation at the American Geophysical Union (AGU) Fall Meeting, Abstract H34B-04.

Evans, T., M. Cox, P. McCord, K.K. Caylor, C. Washington-Ottombre, K. Soderberg, and S. Sadri, 2012. Water Governance, Agricultural Development and Community-level Resilience to Climate Change. Presentation at the American Geophysical Union (AGU) Fall Meeting, Abstract H14F-02.

Soderberg, K., S.P. Good, L. Wang, and K.K. Caylor, 2012. Soil Water Vapor Isotopes as a Tool for Understanding Ecohydrological Processes. Presentation at the 22nd V. M. Goldschmidt Conference, Montreal, Canada

Soderberg, K., S.P. Good, M. O'Connor, E.G. King, and K.K. Caylor, 2012. Evapotranspiration Partitioning in a Semi-arid African Savanna Using Stable Isotopes of Water Vapor. Geophysical Research Abstracts, EGU2012.

Caylor, K.K., S.P. Good, K. Soderberg, and E. King, 2011. Isotope Based Landscape-scale Transpiration Measurements. Presentation at the American Geophysical Union (AGU) Fall Meeting, Abstract B23E-07.

Good, S.P., K. Soderberg, L. Wang, and K.K. Caylor, 2011, Uncertainty in Measurements of dET. Presentation at the American Geophysical Union (AGU) Fall Meeting, Abstract B24B-02.

Soderberg, K., J. Henschel, and S.A. Macko, 2011. Using Stable Isotopes to Understand Survival Strategies of the Living Fossil, Welwitschia Mirabilis. Presentation at the American Geophysical Union (AGU) Fall Meeting, Abstract V13A-2579.

Good, S.P., K. Soderberg, L. Wang, K. Ryan, M. O'Connor and K.K. Caylor, 2011. Air Mass Trajectory Influence on East African Rainfall Isotopic Composition. Presentation at Isoscapes 2011, Purdue University, Indiana.

Good, S.P., K. Soderberg, L. Wang, and K.K. Caylo, 2011. A Direct Comparison of Stable Isotope Evapotranspiration Flux Measurement Techniques with Closed Path Water Vapor Isotope Analysers. Presentation at the 9th International Symposium on Applied Isotope Geochemistry, Tarragona, Spain.

Soderberg, K., S.P. Good, L. Wang, and K.K. Caylor, 2011. Soil Water Vapor Isotopes: Combining Continuous Field Measurements with Experimental and Modeling Approaches in a Semi-Arid Ecosystem. Presentation at the 9th International Symposium on Applied Isotope Geochemistry, Tarragona, Spain.

Soderberg, K., S.P. Good, L. Wang, and K.K. Caylor. 2011. Using the Stable Isotopes of Water in the Soil-Plant-Atmosphere Continuum as a Basis for Understanding Ecosystem Functioning in a Semi-Arid African Savanna. Presentation at the symposium: Hydrogen Isotopes as Environmental Recorders, Orleans, France.

Soderberg, K., L. Wang, S. Good, and K.K. Caylor, 2011. Measurement of Soil Water Vapor Isotopes for Evapotranspiration Partitioning. Geophysical Research Abstracts, v. 13, EGU2011.

Soderberg, K., J. Henschel, R. Swap, and S. Macko, 2011. Environmental Controls on C, N and S Cycling in Plants of the Namib Desert. Geophysical Research Abstracts, v. 13, EGU2011.

Good, S.P., K. Soderberg, G. Kaiyu, E.G. King, and K.K. Caylor, 2011. Savanna Grassland Transpiration Fluxes After Water Pulses Assessed Using Stable Isotope and Eddy Covariance Techniques. Presentation at the Conference on the Roles of Stable Isotopes in Water Cycle Research. Keystone, CO.

Caylor, K.K., L. Wang, S. Good, and K. Soderberg, 2011. Evapotranspiration Dynamics in a Semi-Arid Savanna Using Continuous Water Vapor Isotopes from the Eddy Covariance Flux Tower at Mpala Research Centre, Kenya. Presentation at the 9th Annual Savanna Science Network Meeting, Skukuza, South Africa.

Soderberg, K., J. Henschel, K. Billmark, R.J. Swap, and S.A. Macko, 2010. Multiple Stable Isotope Tracers of Fog Use by Namib Desert Plants. Geophysical Research Abstracts, v. 12, EGU2010.

Soderberg, K., 2010. The Role of Fog in the Ecohydrology and Biogeochemistry of the Namib Desert. PhD Dissertation, Department of Environmental Sciences, University of Virginia.

Soderberg, K., R.J. Swap, and S.A. Macko, 2009. Fog-Aerosol Interactions in the Coastal Namib Desert. Eos Transactions, v. 90, no. 52, Fall Meeting Supplement. Abstract A51D-0138.

Macko, S.A., K. Soderberg, J. Henschel, K. Billmark, and R.J. Swap, 2009. Linking Fog Water Use by Plants in the Coastal Namib Desert to Carbon and Nitrogen Cycles along Aridity Gradients. Eos Transactions, v. 90, no. 52, Fall Meeting Supplement. Abstract B51A-0291.

Soderberg, K., J. Henschel, K. Billmark, and S.A. Macko, 2009. Fog as a Supplemental Water Source for Plants in the Central Namib Desert. Geological Society of America Abstracts with Programs, v. 41, no. 7, p. 464.

Soderberg, K., J. Henschel, and S.A. Macko, 2008. Aridity and Fog Deposition as Controls on C3/CAM Photosynthesis and N-cycling in Welwitschia mirabilis. Eos Transactions, v. 89, no. 53, Fall Meeting Supplement. Abstract B23C-0439.

Soderberg, K., J. Henschel, and S.A. Macko, 2008. WaterRrelations of a Welwitschia mirabilis Community Threatened by Mining in the Namib-Naukluft National Park, Namibia. Presentation at the Society for Conservation Biology 22nd Annual Meeting, Chattanooga, TN.

*Soderberg, K., and J. Compton, 2007. Dust as a Nutrient Source for Fynbos Ecosystems, South Africa. Ecosystems, v. 10, no. 4, pp. 550-561. doi:10.1007/s10021-007-9032-0

*Soderberg, K., and R.J-C. Hennet, 2007. Uncertainty and Trend Analysis—Radium in Groundwater and Drinking Water. Groundwater Monitoring and Remediation, v. 27, no. 4, pp. 122-129. doi: 10.1111/j.1745-6592.2007.00167.x.

Soderberg, K., 2007. Fog Interactions with Surface Ecosystems of the Central Namib Desert and Potential Fog-Aerosol Feedbacks: Initial Ideas. in Benito G, Todd S, eds., Book of Abstracts: Groundwater Recharge in Ephemeral Rivers of Southern Africa: Implications for Water Management. Cape Town, South Africa. p 22.

Soderberg, K., R.J-C. Hennet, and C. Muffels, 2005. Uncertainty and Trend Analysis for Radium in Groundwater and Drinking Water. Presentation at the 2005 NGWA Naturally Occurring Contaminants Conference: Arsenic, Radium, Radon, and Uranium, Charleston, SC. pp.30-44.

Soderberg, K., 2003. Geochemistry of the Fynbos Ecosystem in a Table Mountain Group Sub-Catchment of the Olifants River, Western Cape, South Africa. MS Thesis. University of Cape Town, South Africa.

Compton, J.S., and K. Soderberg, 2003. Water Quality and Geochemistry of the Mountain Fynbos Ecosystem in the Vicinity of Citrusdal, South Africa. Eos Transactions, v. 84, no. 46, Fall Meeting Supplement. Abstract H41D-1038.

Soderberg, K., and J.S. Compton, 2003. Dust Deposition as a Nutrient Source for Fynbos Ecosystems, South Africa. Eos Transactions, v. 84, no. 46, Fall Meeting Supplement. Abstract B21F-0781.

Soderberg, K., and J.S. Compton, 2002. Chemical Interactions Between Groundwater and Surface Ecosystems: An Example from the Table Mountain Group in the Olifants River Valley. Proceedings of the Geological Society of South Africa Regional Groundwater Conference, Somerset West, South Africa.

Soderberg, K., 2000. Sustainable Water Resource Development in North-Central Namibia. Proceedings of the American Water Works Association Section Meeting, Atlantic City, NJ.

Soderberg, K., 2000. Approaches to the Study of Water Resources in North-Central Namibia. BSE Thesis: Dept. of Civil and Environmental Engineering. Princeton University, Princeton, NJ.

DEPOSITION AND TESTIMONY EXPERIENCE

DEPOSITIONS

2017 State of Minnesota v. 3M. 27-CV-10-28862. Expert Report filed September. Deposition October 4. Washington, D.C.

TESTIMONY

2018 Tethyan Copper Company Pty Limited (TCC) v. The Islamic Republic of Pakistan. ICC Case No. 18347/VRO/AGF/ZF/AYZ. Expert Report filed July 24. London, UK.

2018 Tethyan Copper Company Pty Limited (TCC) v. The Islamic Republic of Pakistan. ICSID Case No. ARB/12/11. Expert Report filed April 30. In-person testimony May 19. London, UK.

2014 Before the Illinois Pollution Control Board. R14-10 (Rulemaking – Water). Coal Combustion Waste (CCW) Ash Ponds and Surface Impoundments at Power Generating Facilities. Proposed New 35 Ill. Adm. Code 841. Pre-filed testimony April 9. In-person testimony May 14-15 and July 24. Chicago, IL.

Attachment C

Materials Considered

Attachment C: Materials Considered

Address Locations for Six Class Representatives. Received 9/1/2023 from Motley Rice, LLC.

AERMOD Modeling Files. "Contours.kml". Received 9/5/2023 by direction of Dr. Steven R. Hanna.

ESRI ArcMap Software Version 10.8.1.14362: https://www.esri.com/en-us/home. Accessed 11 September 2023.

GAMLSS. Generalized Additive Models for Location, Scale and Shape: https://www.gamlss.com/. Accessed 2 September 2023.

HYSPLIT Modeling Files. Received 8/31/2023 by direction of Dr. Will Vizuete.

Muhr, D., M. Affenzeller, and J. Küng. 2023. A Probabilistic Transformation of Distance-Based Outliers: *Machine Learning and Knowledge Extraction* 5, no. 3: 782-802.

National Oceanic and Atmospheric Administration. HYSPLIT Model: https://www.ready.noaa.gov/HYSPLIT.php. Accessed 2 September 2023.

Online Video Converter. YouTube Video Downloader: https://en2.onlinevideoconverter.pro/103bM/youtube-video-downloader. Accessed 2 September 2023.

Orfeo ToolBox. Version 8.1.2: https://www.orfeo-toolbox.org/. Accessed 2 September 2023.

The R Foundation. R Version 4.2.1: https://r-project.org. Accessed 2 September 2023.

South Carolina Department of Health and Environmental Control (DHEC). 2023a. Video of Weekly Odor Complaint Maps 1/4/2021 to 11/10/2022. https://scdhec.gov/environment/environmental-sites-projects-permits-interest/new-indy-odor-investigation. Accessed 8/14/2023.

South Carolina Department of Health and Environmental Control (DHEC). 2023b. Video of Weekly Odor Complaint Maps 1/4/2021 to 7/10/2023. https://scdhec.gov/environment/environmental-sites-projects-permits-interest/new-indy-odor-investigation. The DHEC website linked to a video: https://youtu.be/DiKpofJmMx4. Accessed 9/3/2023.

U.S. Census Bureau. 2022. TIGER/Line Shapefiles: https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.2022.html#list-tab-790442341. Accessed 2 September 2023.

Attachment D

Geospatial Image Processing

Attachment D: Geospatial Image Processing

Video files (DHEC 2023a and 2023b) containing still images of weekly odor complaint maps were acquired at full resolution as MP4 files using an online application entitled YouTube Video Downloader (https://en2.onlinevideoconverter.pro/103bM/youtube-video-downloader), converted to still frames as bitmap (.bmp) files, converted to Portable Network Graphics (.png) files, and georeferenced using QGIS v 3.18 referring to Google Maps data served as Web Mapping Service (WMS) tiles.

Odor complaint features were extracted by subtracting the pixel values from each extracted video frame from values in the "Week 0" frame (representing the week of January 4, 2021), which included no odor complaint points. Pixels for which the difference from Week 0 exceeded a threshold value (+- 0.1 Value units when pixel RGB values are converted to HSV, where range = [0, 1]) were masked for inclusion in the vector feature extraction stage.

Pixel regions from masked frames were segmented into individual vector features using the Large Scale Meanshift Segmentation (LSMS) procedure in Orfeo Toolbox v. 8.1.2 (https://www.orfeo-toolbox.org/), which groups contiguous regions of similar pixels and converts them to polygons. Multiple iterations of the procedure helped identify suitable meanshift parameters for segmenting the datasets. Due to the differing video resolutions and feature symbol sizes in the two videos, pixel similarity and region size parameters are not identical between the two analyses. Polygons identified for each frame were exported as ESRI Shapefiles for further analysis. Shapefiles generated by the LSMS procedure were imported into R v. 4.2.1 (https://r-project.org) as Simple Features (SF) data using the sf package (version 1.0-14). Polygon features were spatially reprojected into North Carolina State Plane WGS84 coordinates and processed to identify the centroid, or center point calculated from the area, of each polygon feature. The linear distance between each feature centroid and all other feature centroids was calculated using the st_distance function and, in order to reduce overcounting of features resulting from LSMS segmentation of image noise (outer fringes of pixel features blending with the background map), centroids less than 100 ft away from another centroid were aggregated to a single point.

Feature centroids were grouped by date range into phases, and the average distance from each point to the 10 nearest points within each phase was calculated as a measure of the relative isolation of each feature from other features in the dataset.